REMARKS

Claims 1 and 3-8 are all the claims pending in the application, prior to the present Amendment.

Claims 1, 4, 5, 6, and 8 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Kitagawa et al (*Microstructures and Thermoelectric Properties of* $(FeSb_3)_{1-x}La_x$ *Ribbons*) in view of Lange (*Lange's Handbook of Chemistry, Table 3.2*) and the newly cited Knosp et al (US 20020037453).

Applicant submits that Kitagawa et al, Lange and Knosp et al do not disclose or render obvious the subject matter of claims 1, 4, 5, 6 and 8 as amended above and, accordingly, request withdrawal of this rejection.

Applicant has amended claim 1 to recite "collecting the solidified alloy into a receiving box". Support for this amendment can be found at page 9, line 28 to page 10, line 8.

Collecting the alloy in a receiving box is not disclosed in any of the cited references. As described in the specification beginning at page 9, line 28, the thin alloy pieces which have been solidified in the receiving box allow the cooling rate to be controlled, which enables uniformity of the filled skutterudite phase in the alloy to be further improved.

Further, the Examiner relies on Kitagawa et al for disclosing a filled skutterudite structure comprising a skutterudite-based alloy that is melted at a temperature sufficient to melt at least iron (Fe), and is subsequently spin-casted. The Examiner refers to page 334, second column, first paragraph of Kitagawa et al. In addition, Knosp et al is newly cited and is relied upon by the Examiner for a teaching the claimed cooling rate during strip casting or spin casting.

Applicant previously argued, at pages 6-8 of the Amendment filed October 6, 2008, that Kitagawa et al disclose a "spin-cast" method for making ribbons, and not a "strip-cast" method,

as claimed. Nonetheless, the Examiner again characterizes the spin-cast method of Kitagawa et al as the strip-casting method of the present invention, and does not set forth any reason why he believes the method of Kitagawa et al is a strip casting method.

Kitagawa et al, in the first paragraph of "2. Experimental" at page 334, second column, discloses only the peripheral speed of a copper roll and the thickness of ribbons, but do not disclose what kind of casting method was used. Yet, in the 5th - 8th lines from bottom of the last paragraph of "1. Introduction" at page 334, Kitagawa et al describe that the investigation was carried out in "the spin-cast $(FeSb_3)_{1-x}La_x$ ribbons." (Emphasis added). See also the Abstract of Kitagawa et al which refers to "spin-cast" ribbons. The casting method which Kitagawa et al discloses, therefore, is a spin-cast method, not a strip-casting method.

Also, while Kitagawa et al disclose a process for producing a filled skutterudite-type alloy by the spin-cast method, as explained in applicant's previous Amendment filed on October 6, 2009, the cooling rate used therein can be 10 or more times that of the instant application. The process involves heat treatment (annealing) at a temperature of 973K or 773K for 36 ks (10 hours) and, therefore, is incapable of acquiring the effect of the present application that resides in obviating the necessity of heat treatment.

Since Kitagawa et al do not describe a strip casting process, the combination of the Kitagawa et al spin casting with the cooling rate of the Knosp et al spin casting would not result in the present invention.

Further, there are differences between the alloy disclosed in Knosp et al as compared to that of Kitagawa et al. Knosp et al disclose an alloy with a crystal structure having the formula $CaCu_5$, (see, for example, Knosp et al at paragraph [0012]), whereas Kitagawa et al disclose a filled skutterudite. As disclosed in the present specification, a skutterudite has a crystal structure

of $T(Pn)_3$, and a filled skutterudite has interstitial spaces filled with a rare earth metal R. Since the crystal structure of the alloys of Kitagawa et al and Knosp et al are different, one of ordinary skill in the art would not have been led to combining the teachings of the Kitagawa et al and Knosp et al.

The Examiner, in the Office Action, at page 4, lines 11 - 14, asserts that Knosp et al teach in paragraph [0009] an alloy comprising a rare earth metal, a transition metal, and metallic antimony, and asserts that this alloy is melted and rapidly cooled using either a melt spinning process or strip casting at a cooling rate of 10°C/s to 10^6°C/s as disclosed in paragraphs [0034] and [0036] of Knosp et al.

The alloy disclosed by Knosp et al, however, is an alloy of $CaCu_5$ crystal structure, namely, a hydridable alloy, that is used in the cathode of a "nickel-metal hydride (Ni-MH) storage cell". See paragraphs [0003], [0005], [0012] and [0038] of Knosp et al. In short, it is not the filled skutterudite-type alloy of this application.

The alloy disclosed in paragraph [0009] of Knosp et al is a hydrogen-absorbing alloy that is claimed in U.S. Pat. 5,753,386 to Inaba at al, which is cited by Knosp et al in paragraph [0009], and is not the alloy of the Knosp et al invention.

The composition of the alloy that is claimed in Knosp et al is represented by the chemical formula, $M_mNi_aMn_bA1_cCo_dCr_e$. See paragraph [0012] of Knosp et al. Since M_m is a mischmetal consisting of a mixture of La, Ce, Nd, as disclosed in paragraph [0024] of Knosp et al, the alloy claimed in Knosp et al differs from the hydrogen-absorbing alloy claimed in Inaba et al in respect that it does not necessitate the group consisting of the elements of Y, Fe, Cu, B, Si, 5, Ga, Ge, Mo, Ru, Rh, Pd, Ag, In, Sn, Sb, Bi, P, V, Nb, Ta, and W.

The hydrogen-absorbing alloy claimed in Inaba et al is preferably heat treated in a temperature range of from 500°C - 900°C for 2 - 15 hours, as disclosed at column 11, lines 7-17 of Inaba et al. In contrast, the alloy claimed in Knosp et al is heat treated (annealing) in a temperature range of from 900°C to 1100°C for less than or equal to 16 hours. See paragraph [0032] of Knosp et al.

Thus, the alloy claimed in Knosp differs from the alloy disclosed in paragraph [0009] of Knosp et al (i.e., the alloy claimed in Inaba et al) in terms of composition and conditions of fabrication. Consequently, the alloy disclosed in paragraph [0009] of Knosp et al (i.e., the alloy claimed in Inaba et al) would not necessarily be manufactured even under the conditions of manufacture described in paragraphs [0034] and [0036] of Knosp et al, and claimed in Knosp et al.

As discussed above, the Examiner, at page 4, lines 11 - 14 of the Office Action, asserts that Knosp teaches an alloy comprising a rare earth metal, a transition metal, and metallic antimony that is melted and rapidly cooled using either a melt spinning process or strip casing at a cooling rate of 10°C/second to 10^{6}°C/second. This assertion is in error because the composition of the alloy claimed in Knosp et al is represented by the chemical formula, $M_mNi_aMn_bAl_cCo_dCr_e$, and does not include antimony (Sb).

Further, Knosp et al nowhere specifically disclose the range of 5 x 10^{2}°C/sec to 3 x 10^{3}°C/sec with any casting, and do not disclose this range in connection with *strip-casting*. Examples 1 to 3 of Knosp et al disclose a cooling rate of 10°C/sec for forming a plate in a copper mold, which is well below the presently claimed range. Higher rates of cooling of 10,000 to 100,000°C/sec are disclosed in connection with *atomization* of the alloy in Examples 4 to 6, which are well above the presently claimed range.

Knosp et al disclose a cooling rate of the alloy over a very wide range of 10°C/s to 10^{6}°C/s. Thus, Knosp et al only disclose the range of cooling rates that can be realized in a number of solidification methods, but do not disclose the cooling range of the present claims for strip-casting.

Knosp et al neither disclose the range of temperature of the alloy during rapid cooling of a strip-cast method, nor disclose rapidly cooling between the temperature of the melt and 800°C. Further, Knosp et al neither disclose nor suggest the advantages obtained at a specific cooling rate.

Hence, Knosp et al nowhere disclose or suggest the claimed rate of cooling of the present claims in connection with strip casting.

As compared with Kitagawa et al and Knosp et al, the invention of claim 1 of the present application comprises controlling the cooling rate to within a temperature range from the temperature of the molten alloy to 800°C, to $5x10^2$ to $3x10^3$°C/second in order to attain a filled skutterudite-type alloy. By cooling under the claimed conditions, it is possible to obtain an alloy texture formed of a uniform filled skutterudite phase. See the present specification, page 9, lines 16-22. It is also possible to obtain an alloy exhibiting a maximum peak intensity (namely, abundance ratio), attributed to the filled skutterudite phase of 95% or higher, even when the alloy as removed from a production apparatus employed in the SC (strip cast) process has not undergone any further heat treatment. See the present specification, page 10, line 16 - page 11, line 13.

In addition, new claim 11 depends from claim 1 and further recites that "the receiving box is cooled at a rate of 2 °C/second at a temperature within the range of from 700°C to

500°C." Support for the amendment can be found, *inter alia,* in the specification, page 14, line 29 - page 15, line 10.

When the cooling rate in the receiving box is adjusted, such as in an Ar atmosphere at atmospheric pressure, to 2°C/sec in a temperature range of 700°C to 500°C, the product has a filled skutterudite [$(Ce_x, La_{1-x}) Fe_4Sb_{12}$] phase content of 99% or more, as determined by powder X-ray diffractometry. See page 14, line 29 to page 15, line 10.

As can be seen from the above discussion, the cited documents do not render obvious the subject matter of the present claims.

In view of the above, applicant requests withdrawal of this rejection.

Claim 3 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Kitagawa et al (*Microstructures and Thermoelectric Properties of $(FeSb_3)_{1-x}La_x$ Ribbons*) in view of Lange (*Lange's Handbook of Chemistry, Table 3.2*) and Knosp et al (US 2002/0037453) as applied to claim 1 above, and further in view of Hehmann et al (WO/199604409).

Applicant traverses.

Claim 3 depends from claim 1. Claim 3 is patentable for at least the reasons submitted above in connection with claim 1.

Also, Hermann et al (WO/199604409) disclose a method of using an inert gas only at pp. 31, section 1.1.2 and in the paragraph titled "Melt spinning (MS) and planar flow casting (PFC)" at pp. 70 (particularly at the first to second line from bottom of pp. 70).

Neither of the foregoing paragraphs of Hermann et al specifically disclose the upper limit and the lower limit of the pressure of the inert gas which is effective for curbing the amount of Sb during vaporization.

The alloy disclosed in Hermann et al is an anti-corrosion forged light alloy, such as an aluminum and magnesium alloy, but is not the type of alloy claimed (filled skutterudite-type alloy), and its composition differs from that of the alloy disclosed in Knosp et al.

In view of the above, applicant requests withdrawal of this rejection.

Claim 7 has been rejected under 35 U.S.C. 103(a) as being unpatentable over Kitagawa et al (*Microstructures and Thermoelectric Properties of* $(FeSb_3)_{1-x}La_x$ *Ribbons*) in view of Lange (*Lange's Handbook of Chemistry, Table 3.2*) and Knosp et al (US 2002/0037453) as applied to claim 5 above, and further in view of Hirota et al (US 6,322,637).

Applicant traverses.

The Examiner asserts that it would have been obvious to one of ordinary skill in the art at the time of the invention to keep the oxygen, nitrogen and carbon content of modified Kitagawa's alloy at 0.2 mass% or less, as taught by Hirota et al at column 2, line 6 to column 3, line 7, to achieve desired design characteristics.

Claim 7 also depends from claim 1. Claim 7 is patentable for at least the reasons submitted above in connection with claim 1.

Further, Hirota et al do not relate to a filled skutterudite, but relate to a 4-phase alloy containing an α-iron phase, an R-rich phase, an $R_xT_4B_4$ phase and a $R_2T_{14}B$ phase. Accordingly, one of ordinary skill in the art would not have any reason to combine Hirota et al with Kitagawa et al.

Additionally, Hirota et al do not disclose at column 2, line 6 to column 3, line 7, that their alloys include less than 0.2 mass% or less of oxygen, nitrogen and carbon. Hirota et al do not disclose the oxygen, nitrogen and carbon of their alloys.

Indeed, Hirota et al do not even disclose the amount of impurities contained in an alloy comprising a rare earth element R in combination with a transition metal element and boron B.

In view of the above, applicant requests withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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